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MIRRORS

In previous T.R. 61 we gave some guidelines on how to evaluate aging of optics.
It's a fact that in our CD spectrometer mirrors ages from the day unit is tested at factory.
While this is true in any optical device in a CD unit it's a major concern since a bright Xe source is used and this is special type with quartz envelope, emitting strong UV radiation.
So N_2 flushing is a must to avoid/reduce ozone formation, which is aggressive for mirrors surface.
This is clearly not enough since mirrors ages anyway: in synchrotron radiation beamlines you operate under high vacuum, so no oxygen should be present, but here too mirrors get bad despite cooling and so.

From several years manufacturers are using protected mirrors, which means that a layer of MgF2 covers Al surface :
- coating is very effective since you may clean mechanically the surface without damages
- coating may be effective to improve reflectivity of Al in the low UV range*

** unprotected Al surface quickly loose good reflectivity below 220nm due to formation of an oxide layer*

However experience clearly indicates that coating are not preventing the aging phenomena: a slightly yellow reflection is the (empirical) indicator that replacement is necessary.
Aged coated mirrors, when exposed to bright Xe source, may look much worst than they are: only way to judge is through the actual photomultiplier tube high voltage.
In our experience the facility to clean the surface is usually of no use: in a properly N_2 purged unit very little contaminants are left on the surface, the decay is coming from the actual photochemical damage of the reflecting surface and possibly also of the interface surface/coating**.
*** in FT/IR spectrometers the KBr beam splitter is highly hygrosopic. To extend its lifetime, a thin polymer layer usually covers it. Result is that replacement is now normally due from the damage of the KBr/polymer interface which will scatter the reference HeNe laser radiation when aged, while still properly transmitting the IR radiation!*

We experienced also the case of units which were never N_2 purged: in this case a thin layer of contaminants built up on mirrors surface, this was easy to remove, restoring acceptable performance. Probably the contaminants' layer protected the mirrors!

And now a few practical guidelines:
-mirrors irradiated by white light are obviously the most stressed ones, this means light source mirrors, but also somehow the first monochromator mirror, which too is filled by white light only attenuated by the entrance slit aperture.
-replacement frequency depends much on your attitude to accept compromises, but in general light source mirrors should be changed any three lamp replacements, i.e. at about 3000 hours interval.
-with new lamp and new mirrors performances should be restored as from a new unit. This is typically not true, even if a trained engineer carries on the job. Reason is simple, there is another reflecting surface irradiated by white light: the prism of the first monochromator. Its reflective coating will age as well! Unfortunately prism replacement is tricky and expensive***.
**** grating monochromator CDs (as the APP one) will have the stress on the first grating surface ……, people who uses HPLC fluorescence detectors or who are extensively using spectrofluorometers should have good experience on the need to replace Ex grating from time to time…..*
- N_2 purging is a must, but all optional devices to shut-off the lamp is N_2 flow give only psychological benefits. Deterioration is not caused by short term, occasional, operation without N_2!
-a periodical, regular check of the photomultiplier tube high voltage all over the spectral range or at selected wavelengths is the best way to keep situation under control and to plan in advance correcting procedures.

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